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COLLEGE OF FOOD, AGRICULTURAL AND ENVIRONMENTAL SCIENCES / DEPARTMENT OF ENTOMOLOGY

Augmentative biological control of twospotted spider mite on hops in the midwest

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ABSTRACT

The twospotted spider mite, *Tetranychus urticae*, is a key pest on hops grown in Ohio. We conducted trials to determine the efficacy of augmentative biological control using the predatory mites *Galendromus occidentalis* and *Neoseiulus fallacis* in 2016 and 2017. Although hop cone yields in our augmentation study did not differ significantly, concurrent enclosure studies showed that in conjunction with natural enemies present in the hop yard, *N. fallacis* can provide adequate control of spider mites when released at a rate of one predators per five spider mites. We observed that the naturally occurring predator complex, which include *N. fallacis*, provide substantial control of *T. urticae*. Future studies might concentrate on identifying conservation biological control tactics where growers would enhance the activities of natural enemies already present in the system, rather than releasing purchased predators.

Figure 1. *Tetranychus urticae* motiles and an egg. (David Cappaert, Bugwood.org)

INTRODUCTION

After almost one hundred years with no recorded production, hops, *Humulus lupulus* L., has made a resurgence in the state of Ohio, the result of a dramatic increase in local breweries and their demand for locally produced hops. Growing hops in Ohio unfortunately presents many challenges including the twospotted spider mite, *T. urticae*, a phytophagous mite that can cause significant damage to hop plants. *T. urticae* colonizes the hop cones causing them to become dry and brittle with a tendency to shatter, thus lowering yield quality and quantity (Cranham 1985). *T. urticae* can be controlled by conventional pesticides, but because of their short life cycle, parthenogenic reproduction, and abundant progeny, *T. urticae* populations can rapidly develop resistance, thereby limiting growers' options (Van Leeuwen et al. 2010). Pesticide resistance and greater awareness of ecologically sound pest management practices have resulted in growers' increased interest in biological control (Attia et al. 2013).

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Cranham, J.E. 1985. Hop. In: Heel, W., Sabelis, M.W. (eds.) Spider mites: their biology, natural enemies and control, Volume 1A. Elsevier Science Publishers B.V., Amsterdam, The Netherlands, pp. 367–370.

Van Leeuwen, T., Vontas, J., Tsagkarakou, A. Tirry, L. 2010. Acaricide resistance mechanism in the two-spotted spider mite *Tetranychus urticae* and other important Acari: a review. Insect Biochem. Molec. 40, 563–572.

EXCLUSION STUDY – 2017

Objectives

- Measure the impact of natural enemies on *T. urticae* population growth
- Determine if either a predator prey ratio of 1:10 or 1:5 is adequate for suppressing *T. urticae* populations

Methods

- Location: 4 hop yards in Ohio
- 100 replicates
- Pair of leaves chosen on a hop plant
- All arthropods and eggs removed from leaves
- Ten female spider mites added to each leaf
- Zero, one, or two predatory mites (*Neoseiulus fallacis)* added to each leaf
- One leaf in each pair covered with a fine mesh bag (Fig. 2)
- Leaves collected and spider mite eggs and motiles counted after one or two weeks

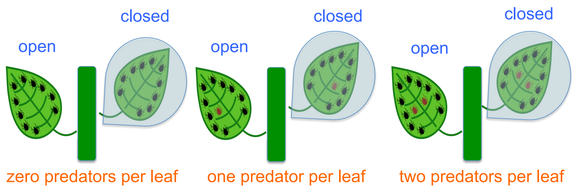

Figure 2. Six treatments in exclusion study.

Results

Number of spider mite motiles after two weeks

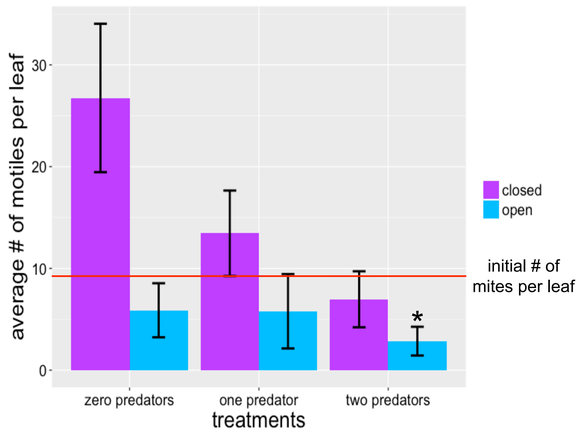

Figure 3. Spider mite motiles present after two weeks. * denotes treatment significantly less than 10.

Conclusions

- Arthropod predators present in Ohio hop yards can provide substantial spider mite control.
- In conjunction with natural enemies present in the hop yard, *N. fallacis* was able provide adequate control of spider mites when released at a rate of two predators per ten spider mites.

AUGMENTATION STUDY – 2016 and 2017

Objectives

- Document *T. urticae* seasonal population trends on hops
- Evaluate augmentative biological control of *T. urticae* by two predatory mite species (*Galendromus occidentalis* and *Neoseiulus fallacis*)
- Determine if a high or a low predator release rate is adequate for suppressing *T. urticae* populations

Methods – 2016

Sampling

- Location: 4 hop yard in Ohio
- Plot Size: 3 plants
- Leaf samples collected weekly to monitor spider mite motiles and eggs
  - 2 leaves 1 m from ground
  - 2 leaves 1 m from top of plant

Predator Release

- Randomized complete block
- Treatments (8 replicates)
  - Control – no predator release
  - Low rate *G. occidentalis*
    - 10 per plant
  - High rate *G. occidentalis*
    - 20 per plant
  - Low rate *N. fallacis*
    - 10 per plant
  - High rate *N. fallacis*
    - 20 per plant
- Predators released at a threshold of 1 spider mite / 10 leaves
- If populations continued to increase, predators were re-released 2 weeks later (maximum two releases)

Yield Comparison

- Hop cones harvested, yields measured
- Treatments were compared using a one way t-test

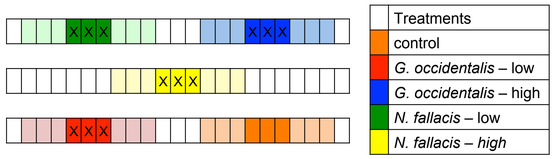

Figure 4. Plot map - 2016. Each box represents one hop plant. Deeply shaded boxes are the plots. Lightly shaded boxes are plants monitored for predator spread. 'X' denotes predator release.

Methods – 2017

- Location: 4 hop yard in Ohio
  - two new sites, two same as 2016
- More intense sampling than 2016
  - 5 leaves 1 m from ground
  - 2 leaves 1 m from top of plant
- Treatments (17 replicates)
  - Control – no predator release
  - Low rate *N. fallacis*
    - 10 per plant
  - High rate *N. fallacis*
    - 50 per plant
- All other methods remained the same

Results

2016 Hop Yields

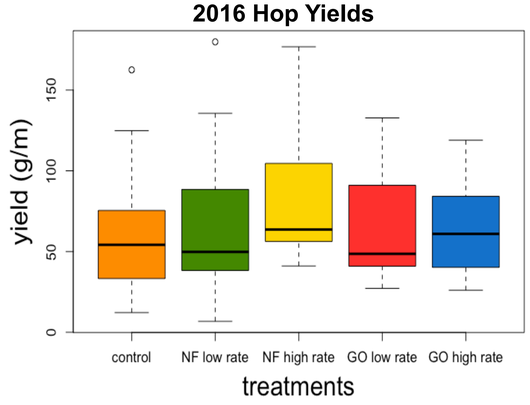

Figure 5. Hop yields from 2016. (NF = *N. fallacis;* GO = *G. occidentalis*) Means show no statistical difference. Similar results were found in 2017.

Spider Mite Population Trends 2017

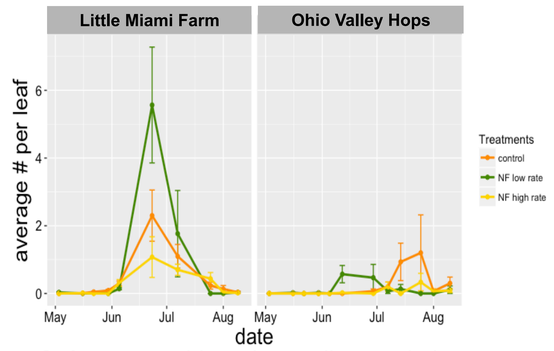

Figure 6. Average spider mite motile populations at two farms in 2017. These farms are representative of the large variation observed among farms and within farms.

Conclusions

- *T. urticae* start to appear on hop plants in early May.
- Once present, populations quickly increase.
- Populations vary greatly from leaf to leaf and plant to plant.
- Populations crash in late-July / early-August before hop harvest in mid - August.
- Several species of predatory mites, including *N. fallacis*, are present in Ohio hop yards.
- The quality of commercially available *G. occidentalis* is not adequate for augmentative biological control.
- When released at either a high or a low rate, *N. fallacis* was unable to suppress spider mite populations on hops.
- Future studies might concentrate on identifying conservation biological control tactics.

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